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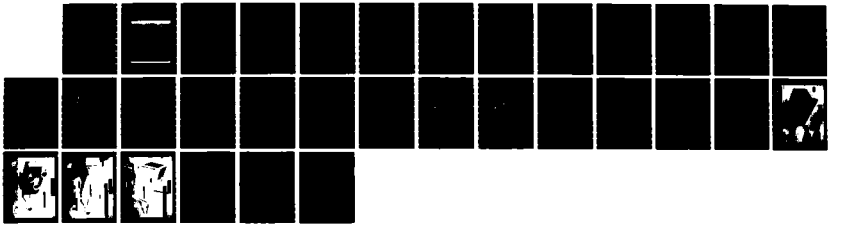

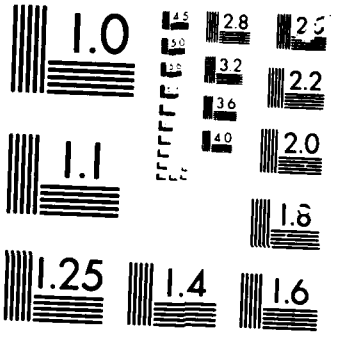
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# RD&E CENTER

# Technical Report

**No.** 13155

CONCEPT STUDY-

VEHICLE WASTE DISPOSAL SYSTEM

(PHASE I)

CONTRACT NUMBER DAAE07-85-C-R089

JANUARY 1986



Carter K. Lord

OLIS Engineering,
a division of OLIS Enterprises, Inc.
P.O. Drawer 408 D
**By** Sedalia, Colorado 80135



U.S. ARMY TANK-AUTOMOTIVE COMMAND
RESEARCH, DEVELOPMENT & ENGINEERING CENTER
Warren, Michigan 48397-5000

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SECURITY CLASSIFICATION OF THIS PAGE

AD-A169045

# REPORT DOCUMENTATION PAGE

| | |
|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>Unclassified | 1b. RESTRICTIVE MARKINGS<br>None |
| 2a. SECURITY CLASSIFICATION AUTHORITY | 3. DISTRIBUTION / AVAILABILITY OF REPORT<br>Approved for Public Release:<br>Distribution is Unlimited |
| 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S) | 5. MONITORING ORGANIZATION REPORT NUMBER(S) |
| 6a. NAME OF PERFORMING ORGANIZATION<br>OLIS Engineering, a division of OLIS Enterprises, Inc.<br>6b. OFFICE SYMBOL (If applicable)<br>N/A | 7a. NAME OF MONITORING ORGANIZATION<br>DCASMA - DENVER |
| 6c. ADDRESS (City, State, and ZIP Code)<br>P.O. Drawer 408 D<br>2433 N. Perry Park Rd.<br>Sedalia, Colorado 80135 | 7b. ADDRESS (City, State, and ZIP Code)<br>701 W. Hampden Ave., Suite E3210<br>Englewood, Colorado 80154-1044 |
| 8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Tank-Automotive Command, R&D Center<br>8b. OFFICE SYMBOL (If applicable)<br>AMSTA -NR | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State, and ZIP Code)<br>TACOM<br>Warren, Michigan 48397-5000 | 10. SOURCE OF FUNDING NUMBERS<br>PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO. |

11. TITLE (Include Security Classification)
CONCEPT STUDY - VEHICLE WASTE DISPOSAL SYSTEM

12. PERSONAL AUTHOR(S)
Carter K. Lord

| 13a. TYPE OF REPORT | 13b. TIME COVERED | 14. DATE OF REPORT (Year, Month, Day) | 15. PAGE COUNT |
|---|---|---|---|
| Final | FROM 85/08/01 TO 86/01/28 | 86/01/28 | 46 |

16. SUPPLEMENTARY NOTATION

| 17. COSATI CODES | | | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |
|---|---|---|---|
| FIELD | GROUP | SUB-GROUP | Waste Disposal System, Vehicle Mounted, NBC environment |
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This concept study was initiated to investigate the feasibility of developing a waste disposal system to process and dispose of human waste generated in combat vehicles operating in a nuclear, biological, and chemical (NBC) contaminated environment.

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| 20. DISTRIBUTION / AVAILABILITY OF ABSTRACT<br>☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Moshin Singapore | 22b. TELEPHONE (Include Area Code)<br>(313) 574-5373<br>22c. OFFICE SYMBOL<br>AMSTA - NR |

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted.
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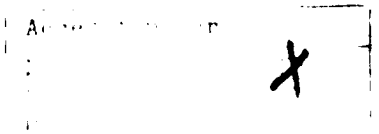


A-1

## LIST OF ILLUSTRATIONS

## 1.0. INTRODUCTION

This final technical report was prepared by OLIS Engineering, a division of OLIS Enterprises, Inc., for the U.S. Army Tank-Automotive Command (TACOM) under Contract DAAE07-85-C-R089. It describes the Phase I concept study which was performed for the specific purpose of defining a viable approach to providing an efficient means of disposing of human waste generated within combat vehicles while operating in a nuclear, biologically, or chemically (NBC) contaminated environment. The research performed resulted in the preliminary design of a waste processing unit which has been shown to be feasible both in concept and application. The unit, when fully developed, will be capable of meeting the requirements identified for a waste disposal system for combat vehicles.

## 2.0. OBJECTIVE

The primary objective of Phase I of this research was to define a waste disposal system for combat vehicles operating in an NBC contaminated environment. A system is needed which will safely and efficiently process and dispose of the human waste generated within the confines of a combat vehicle operating under conditions which prohibit opening the vehicle to dispose of the generated waste. As space, power, and water are extremely limited in the types of vehicles under consideration, concepts were defined which require a minimum of those commodities. While developing a viable waste disposal system for this specific application, it was also a goal of this research to identify and pursue any possible commercial applications of the systems defined.

## 3.0. CONCLUSIONS

The research performed under Phase I of this contract has identified a viable approach to the efficient disposal of human waste from within a combat vehicle operating in an NBC environment with minimum impact to the vehicle or to the personnel operating within that vehicle. The feasibility of the approach has been demonstrated both by analysis and preliminary testing. With further development, the concept defined should be capable of meeting the requirements identified for this application, as well as possible commercial applications identified by this study.

## 4.0. RECOMMENDATIONS

Based on the results of Phase I of this concept study, the following plan for development of a concept Waste Processing Unit (WPU) is recommended. The primary purpose of this work will be to develop a WPU capable of being installed and utilized in a concept combat vehicle, specifically the Concept Command Post Vehicle (CCPV) currently under development.

## 4.1. Bench Model Testing

Testing of the existing bench model (with recommended modifications, see Figure 4-1) should be performed under simulated operating conditions to determine performance, operational problems, etc., and to identify any required design modifications.

## 4.2. Development Unit Design

4.2.1. WPU Development Unit. A Development Unit of the WPU to fit within the confines of the CCPV, to be powered by a portion of the exhaust from the Auxiliary Power Unit (APU) of that vehicle needs to be designed. The results of the bench model testing should be used in the design.

4.2.2. Waste Disposal Port (WDP) Design. A WDP for the WPU to permit depositing bagged waste into the unit while operating also needs to be designed. It must provide interlocks to prevent opening the WDP when the APU is not functioning.

4.2.3. Marine WPU Development Unit. We also recommend designing a development model of the WPU for the specific application of processing waste from a marine head.

## 4.3. Development Unit Fabrication

Following completion of the recommended design effort specified above, the Development Unit WPU's and required support hardware for testing (an efficient test stand is strongly recommended) should be fabricated.

## 4.4. Development Unit Testing

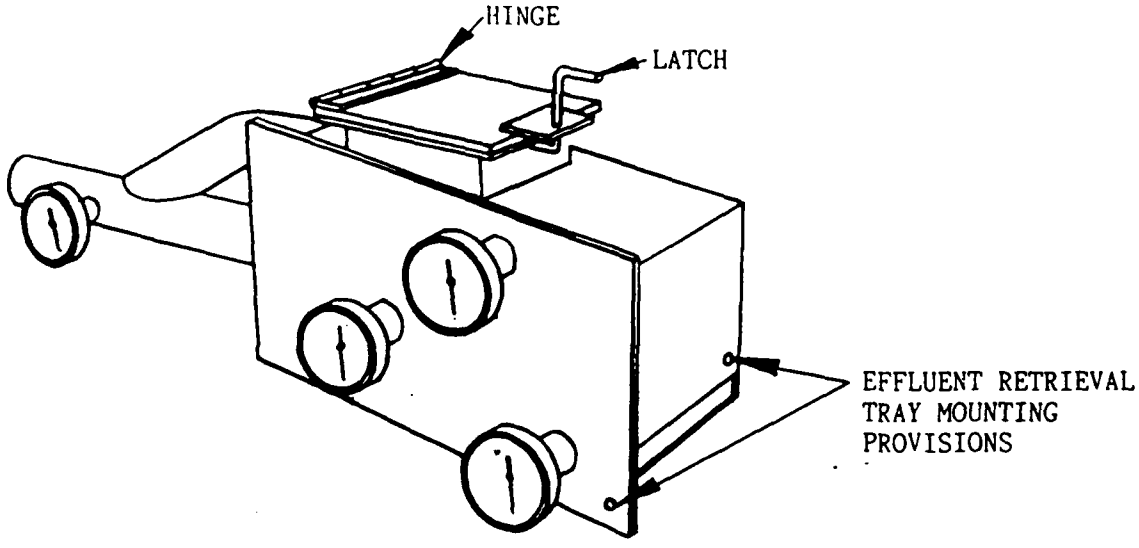
Development testing of the WPU and WDP should be performed under simulated actual conditions to verify operational performance and characteristics.

## 4.5. Operational Manual

An operational manual should be prepared to clearly identify the proper procedures for the use of an installed WPU based on the testing of the WPU Development Units.

## 4.6. Refurbishment and Installation

Following the completion of all development testing, the WPU and WDP Development Units should be refurbished as required in preparation for field testing. The hardware required to install the WPU and WDP into the CCPV should be designed and fabricated, and the refurbished WPU and WDP Development Units should then be installed on the CCPV for field testing as specified by TACOM.




1. Add hinge and latch to waste dump chute to facilitate loading unit when hot.
2. Add provisions for attaching an effluent retrieval tray.
3. (Not Shown) Use bench model to evaluate candidate insulation materials.

Figure 4-1. Bench Model WPU - Recommended Modifications

## 4.7. Commercial Development

It is recommended that the Marine WPU be developed and tested to a level permitting presentation to the public market (advertising) for use in various pleasure boats and commercial fishing fleets. Many commercial applications of the standard WPU exist also, and those should be developed to their maximum potential.

# 5.0. DISCUSSION

## 5.1. Description of Work

To define a viable vehicle waste disposal system for combat vehicles operating in an NBC contaminated environment, the following work was performed.

5.1.1. Concept Definition. Several concepts of vehicle waste disposal systems were defined by the principal investigator, and developed to a level which permitted evaluation of the concepts with respect to feasibility, reliability, power requirements, adaptability to different vehicle systems, ability to process expected types and quantities of waste material, and cost. Waste collection and storage systems, waste collection and disposal systems, and waste processing and disposal systems were considered. Wherever possible, existing technology was used in the conceptual designs. Possible commercial applications of the concepts defined were identified during the course of the study, and are currently being pursued further. Concepts defined for evaluation are shown in APPENDIX A.

5.1.2. Concept Evaluation. The conceptual designs of the vehicle waste disposal systems developed were evaluated by the principal investigator and staff at OLIS Engineering to determine specific projected characteristics of each concept. Existing systems and modified existing systems were included in this evaluation.

5.1.3. Working Model Fabrication/Evaluation. A working model of the WPU, concept 9, was fabricated to demonstrate the feasibility of the approach. It is stressed that this unit is a working model, or bench model, for concept demonstration and evaluation purposes only, and is not intended to be installed into a vehicle for testing. The bench model WPU is shown in APPENDIX B, as are the results of the preliminary testing performed.

5.1.4. Research Plan. Based on the results of the research performed during Phase I of the study, recommendations for the further development of the most promising concepts defined were made, and are presented in Section 4.0. of this report. The recommendations identify specific areas which, in the estimation of the research staff, will require further detailed analysis or definition, and define a specific approach to the development of the concept to an operational level.

## 5.2 Project Results

A total of nine concept vehicle waste disposal systems were defined and evaluated by this study (see APPENDIX A). As a result of the trade study performed, and discussions with the TACOM staff cognizant of this research, the most attractive concept for this specific application is a unit which incinerates the human waste generated and disposes of the ash through the APU exhaust system. The concept WPU uses no vehicle power or ancillary equipment. Its sole power source is the waste heat and airflow supplied by the APU exhaust system.

A bench model of the concept WPU was fabricated at OLIS Engineering. Preliminary testing was started prior to the completion of Phase I of the study. Preliminary results of the testing indicate that not only will the WPU concept function efficiently when powered by the exhaust from the APU of the CCPV (a Garret turbine engine with an exhaust temperature of approximately 1200°F), but will also operate when powered by the exhaust from a standard (6 cylinder automotive type) gasoline internal combustion engine. These data permit further investigation of a promising possible commercial and military application of the concept-- waste processing aboard various marine craft. Current laws in many areas require pleasure craft and commercial fleets to chlorinate and macerate human waste before dumping into the local waters. Macerators currently available are inefficient, and are reported to be unreliable. A WPU, installed in the exhaust system of a boat, and receiving waste from a standard marine head, would effectively allow chlorinated liquid waste to pass through the system, while retaining solids for incineration by the engine exhaust.

Following completion of Phase I of the research, a research plan was prepared to identify the recommended approach to further development of the concept WPU into an operational unit, with both military and commercial applications. The research plan is summarized in this report in Section 4.0., and specifies further testing of the bench model WPU, as well as design, fabrication, and testing of a more advanced prototype unit with an efficient waste delivery system for the specific application of the CCPV. It is anticipated that further development of the WPU concept can also result in a simpler, more efficient approach to introducing the waste into the WPU than the baffled dump chute currently shown; this effort is also recommended.

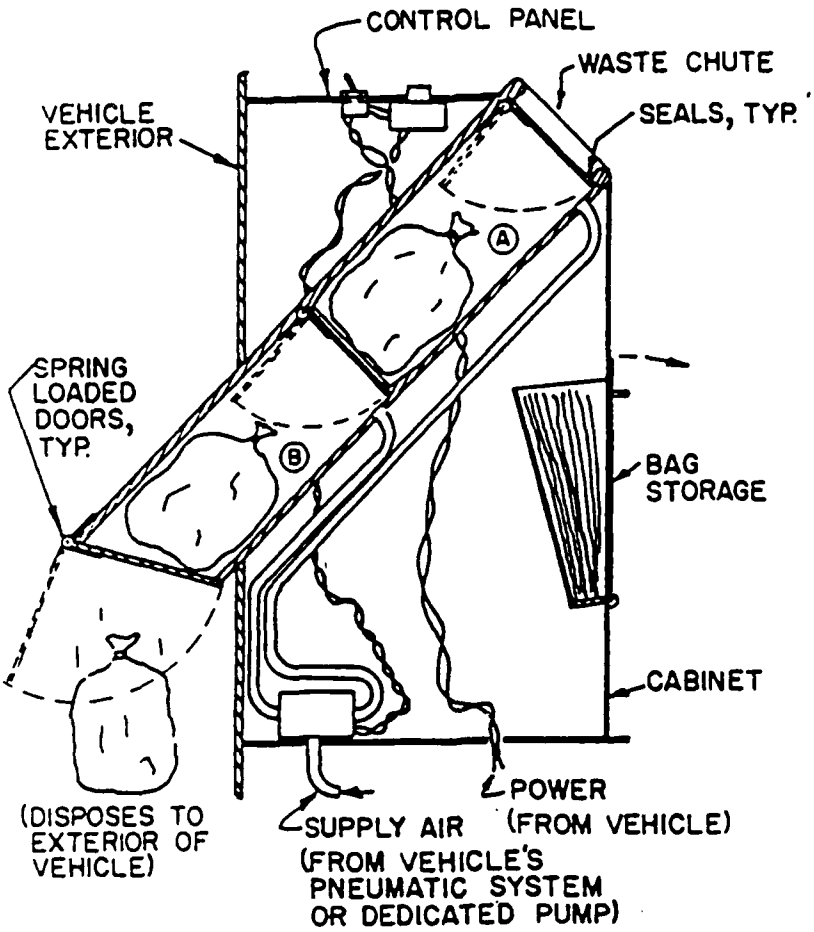
## SELECTED BIBLIOGRAPHY

Lord, C.K., "Background Data Report for Concept Study - Vehicle Waste Disposal System", OLIS Engineering, Sedalia, CO (1985)

# APPENDIX A

# CONCEPT DEFINITION SHEETS

## CONCEPT #1 - BAFFLED DUMP SYSTEM




### OPERATIONAL SEQUENCE

1) WASTE IS PLACED IN PLASTIC BAG AND BAG IS CLOSED WITH WIRE TIE.

2) FILLED BAG IS PLACED IN COMPARTMENT A

3) WHEN "OPERATE" BUTTON IS PRESSED, UNIT AUTOMATICALLY CYCLES AS FOLLOWS:

   a) COMPARTMENT B PURGE
   b) PRESSURIZE COMPARTMENT A, TRANSFERRING WASTE TO COMPARTMENT B.
   c) PRESSURIZE COMPARTMENT B, DISPOSING OF WASTE.
   d) PURGE COMPARTMENT A, WHICH AUTOMATICALLY PURGES COMPARTMENT B .
   e) UNIT SHUT DOWN.

### ADVANTAGES:

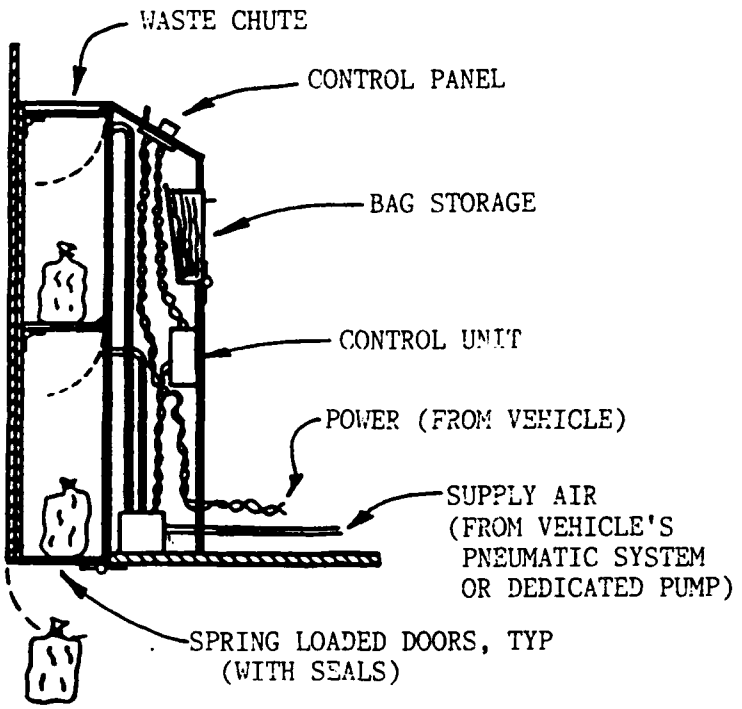
- LOW POWER REQUIREMENTS
- HIGH CAPACITY (LIMITED ONLY BY BAG SUPPLY)
- SIMPLE OPERATION
- HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
- DOES NOT REQUIRE PERSONNEL TO LEAVE VEHICLE TO EMPTY SYSTEM
- LOW TECHNICAL RISK
- LOW MAINTENANCE REQUIREMENTS
- LOW COST

### DISADVANTAGES

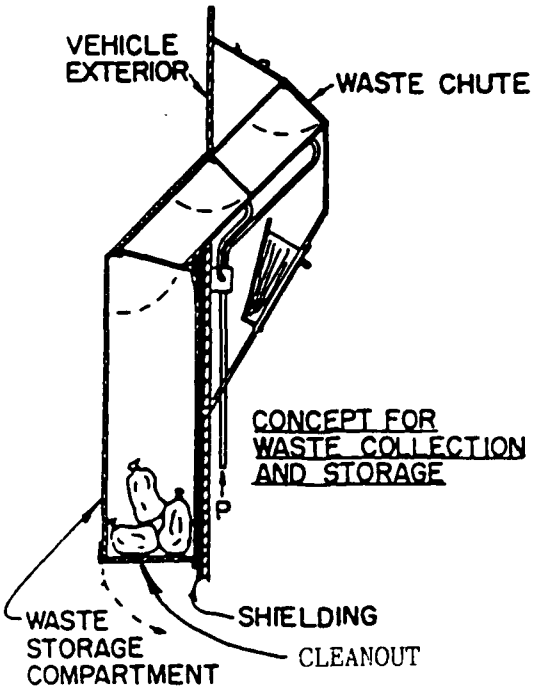
- WASTE IS DEPOSITED DIRECTLY ON GROUND (CAUSING PROBLEMS DURING NON-COMBAT OPERATION, AND POSSIBLY PERMITTING TRACKING OF VEHICLE MOVEMENTS DURING COMBAT)

CONCEPT #1 - BAFFLED DUMP SYSTEM

ALTERNATE CONFIGURATION



## CONCEPT #2 - BAFFLED COLLECTION SYSTEM




### OPERATIONAL SEQUENCE

1)WASTE IS PLACED IN PLASTIC BAG AND BAG IS CLOSED WITH WIRE TIE.

2)FILLED BAG IS PLACED IN COMPARTMENT A

3)WHEN "OPERATE" BUTTON IS PRESSED, UNIT AUTOMATICALLY CYCLES AS FOLLOWS:

a)COMPARTMENT B PURGE
b)PRESSURIZE COMPARTMENT A, TRANSFERRING WASTE TO COMPARTMENT B.
c)PRESSURIZE COMPARTMENT B, DISPOSING OF WASTE.
d)PURGE COMPARTMENT A, WHICH AUTOMATICALLY PURGES COMPARTMENT B .
e)UNIT SHUT DOWN.

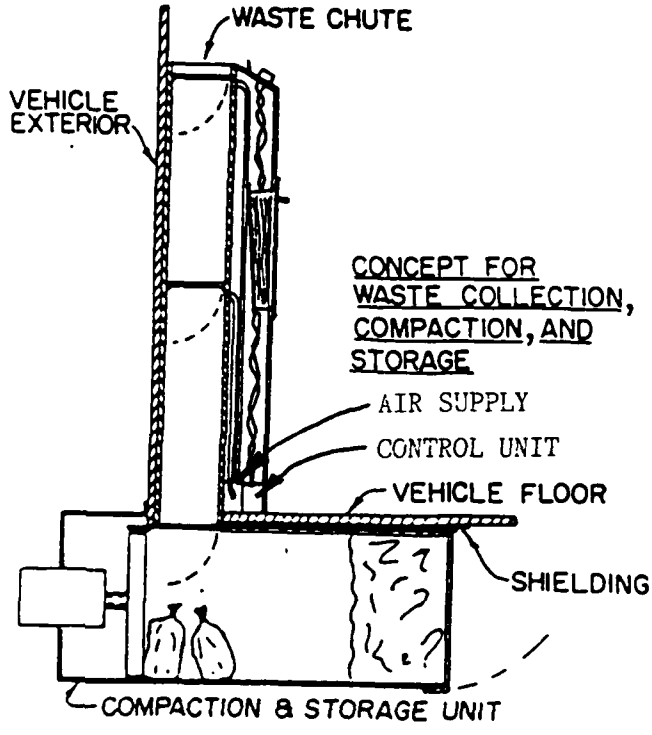
ADVANTAGES:

°STORES WASTE FOR LATER DISPOSAL
°LOW POWER REQUIREMENTS
°MEDIUM CAPACITY (LIMITED BY STORAGE COMPARTMENT VOLUME)
°HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
°LOW TECHNICAL RISK
°LOW COST
°LOW MAINTENANCE REQUIREMENTS

DISADVANTAGES:

°REQUIRES LARGE WASTE STORAGE COMPARTMENT
°OVERFILLING OF STORAGE COMPARTMENT MAY JAM LOWER BAFFLE
°REQUIRES PERSONNEL TO LEAVE VEHICLE TO EMPTY SYSTEM
°IF BAGS RUPTURE IN STORAGE COMPARTMENT, CLEANOUT WILL BE MOST UNPLEASANT.

## CONCEPT #3 - BAFFLED COMPACTION SYSTEM




### OPERATIONAL SEQUENCE

1)WASTE IS PLACED IN PLASTIC BAG AND BAG IS CLOSED WITH WIRE TIE.

2)FILLED BAG IS PLACED IN COMPARTMENT A

3)WHEN "OPERATE" BUTTON IS PRESSED, UNIT AUTOMATICALLY CYCLES AS FOLLOWS:

a)COMPARTMENT B PURGE
b)PRESSURIZE COMPARTMENT A, TRANSFERRING WASTE TO COMPARTMENT B.
c)PRESSURIZE COMPARTMENT B, DISPOSING OF WASTE.
d)PURGE COMPARTMENT A, WHICH AUTOMATICALLY PURGES COMPARTMENT B .
e)UNIT SHUT DOWN.

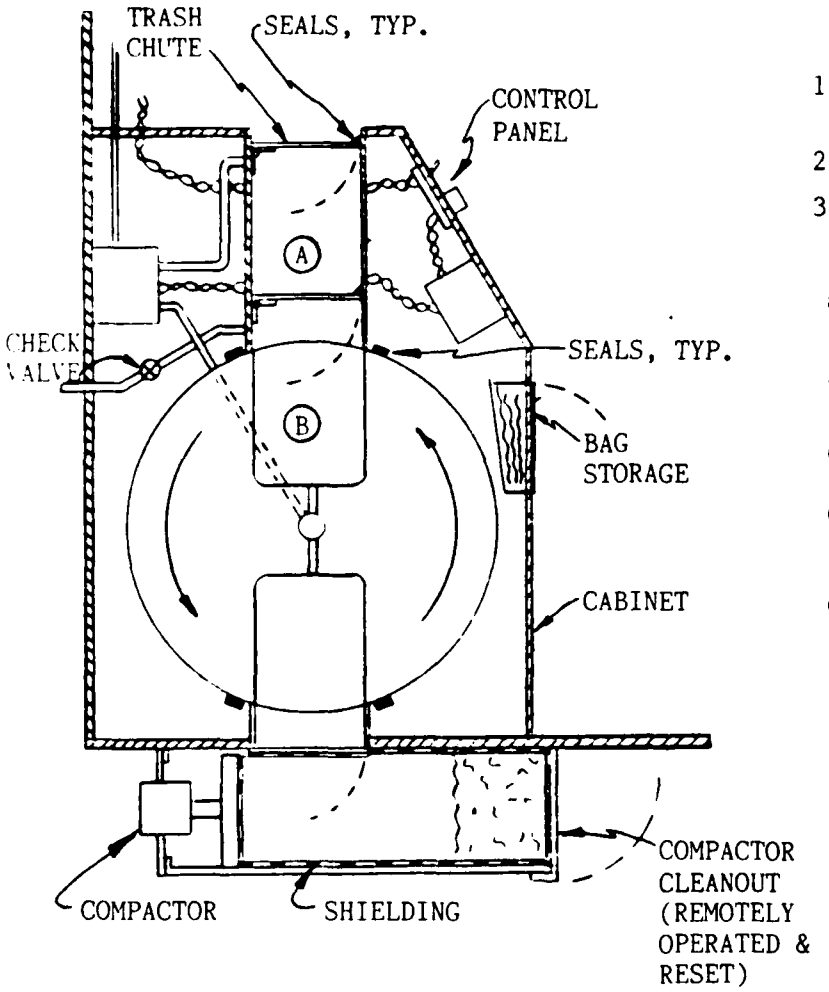
### ADVANTAGES:

°LOW POWER REQUIREMENTS
°HIGH CAPACITY (LIMITED BY COMPACTED WASTE VOLUME)
°SIMPLE OPERATION
°STORES WASTE FOR LATER DISPOSAL
°HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
°NORMAL OPERATION: MAINTENANCE CREW CLEANOUT
COMBAT OPERATION- EXTENDED MISSIONS - CLEANOUT DOOR JETTISON - NO NEED TO LEAVE VEHICLE TO EMPTY SYSTEM
°LOW TO MEDIUM COST
°LOW TO MEDIUM TECHNICAL RISK
°LOW TO MEDIUM MAINTENANCE REQUIREMENTS

### DISADVANTAGES:

°OVERFILLING OF COMPACTOR MAY REQUIRE JETTISONING OF COMPACTOR CLEANOUT DOOR DURING LONG MISSIONS
°MAINTENANCE OF COMPACTOR WILL BE UNPLEASANT DUE TO RUPTURED BAGS

## CONECPT #4 - ROTARY BAFFLE COMPACTION SYSTEM




OPERATIONAL SEQUENCE

1) WASTE IS PLACED IN BAG & SEALED WITH WIRE TIE.
2) BAG IS PLACED IN COMPARTMENT (A).
3) WHEN "OPERATE" BUTTON IS PRESSED, UNIT AUTOMATICALLY CYCLES AS FOLLOWS:
   a) PRESSURIZE COMPARTMENT (A), TRANSFERRING WASTE TO COMPARTMENT (B).
   b) ROTATE COMPARTMENT B 180° CCW TO THE DUMP POSITION.
   c) PRESSURIZE COMPARTMENT (B) TO DUMP WASTE INTO COMPACTOR.
   d) ACTIVATE COMPACTOR & ROTATE COMPARTMENT (B) 180° CCW TO INITIAL POSITION.
   e) PURGE COMPARTMENT (B) TO OUTSDIE THROUGH CHECK VALVE.
   f) UNIT SHUT DOWN.

ADVANTAGES:

°NO DIRECT PATH TO CONTAMINATED STORAGE/COMPACTION AREA

DISADVANTAGES:

°HIGH TECHNICAL RISK

°PROBABLE SEAL PROBLEMS

°LARGE UNIT VOLUME

°MEDIUM POWER REQUIREMENTS

°HIGH COST

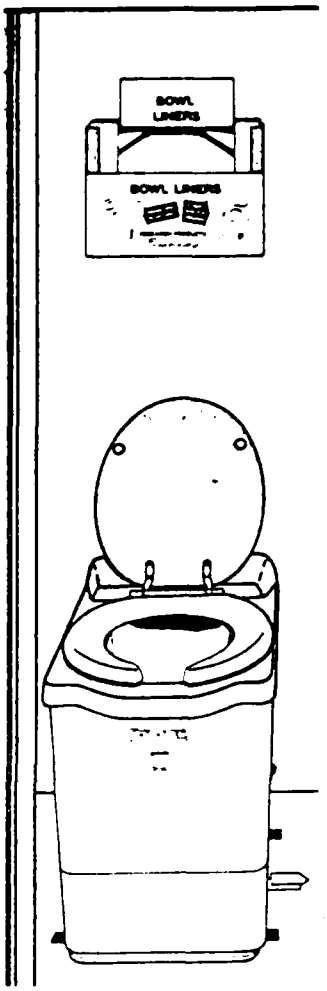
°HIGH WEIGHT

°CHECK VALVE REQUIRED TO PURGE COMPARTMENT (B)

°HIGH MAINTENANCE REQUIREMNTS (MECHANICAL)

## CONCEPT #5 - INCINERATION SYSTEM

(EXISTING SYSTEM)




### SPECIFICATIONS

HEIGHT ----------21 in.
WIDTH----------15 in.
DEPTH ----------26 in.
VENTING----------140 CFM (min.)
200 CFM (max)
POWER ----------3750 watts @120/208 VAC
or 120/240 VAC

°USES WAX PAPER LINER FOR EACH USE
°REQUIRES MAKEUP AIR FOR BLOWER (30 sq. in. min. for makeup air opening)
°CYCLE TIME: 60 min.
°CAPACITY: 6 PERSONS
°COST: $1860.00 per unit (with instl kit)

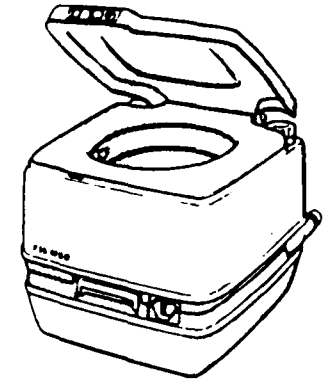
ADVANTAGES:

°LOW COST
°SIMPLE OPERATION
°ADEQUATE CAPACITY (EXCEPT FOR APC)
°PROVEN DESIGN (LOW TECHNICAL RISK)
°MEDIUM TO LOW MAINTENANCE

DISADVANTAGES:

°WILL NOT DISPOSE OF CANS, BOTTLES, OR HIGHLY COMBUSTIBLE MATERIALS, SUCH AS OILY RAGS, ETC.
°SHOULD NOT BE INSTALLED IN ANY LOCATION WHICH MAY BECOME EXPLOSIVE OR REQUIRING EXPLOSION PROOF COMPONENTS OR WIRING
°COMPLEX VENTING AND MAKEUP AIR REQUIREMENTS (HIGH INTERNAL CONTAMINATION RISK)
°HIGH POWER REQUIREMENTS
°NO MEANS OF DISPOSING OF WASTE ASH IN CLOSED HATCH CONDITIONS.
°VIBRATION CAUSES RAPID DEGRADATION OF CATALYST PELLETS
°HIGHLY DETECTABLE SIGNATURE DURING INCINERATION CYCLE (THERMAL)
°LONG CYCLE TIME

## CONCEPT #6 - CHEMICAL TOILET
(EXISTING SYSTEM - MARINE HEAD WITH *PUMPOUT*)



### SPECIFICATIONS

°SELF CONTAINED WATER SUPPLY
°SELF CONTAINED WASTE HOLDING TANK CAN BE PUMPED OVERBOARD (TO EXTERIOR OF VEHICLE) WHEN FULL
°CHEMICAL ADDITIVE IN WASTE HOLDING TANK ELIMINATES ODORS
°NO POWER REQUIREMENTS

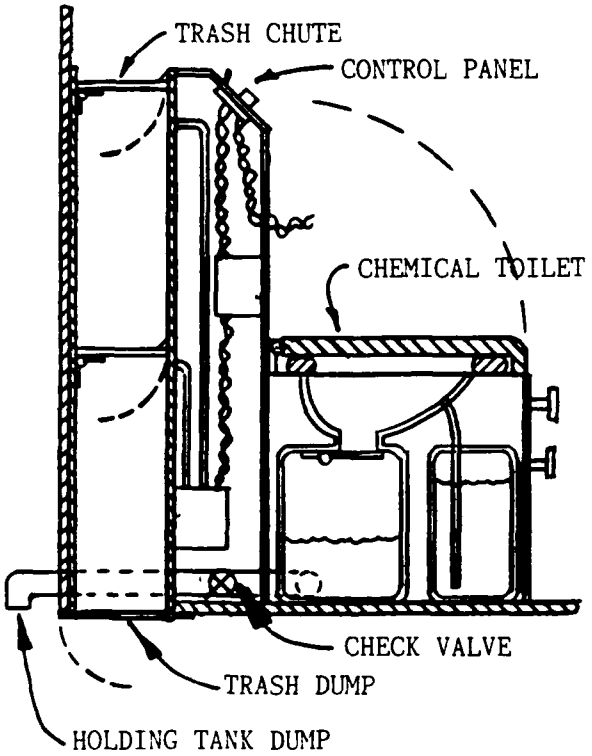
ADVANTAGES:

°NO POWER REQUIRED
°CAN HOLD WASTE FOR LATER DISPOSAL, OR DUMP OVERBOARD (TO VEHICLE EXTERIOR) WHEN FULL (CHECK VALVE PREVENTS CONTAMINATION FROM EXTERIOR)
°SIMPLE OPERATION
°FAMILIAR DESIGN (MINIMUM PERSONNEL TRAINING REQUIRED)
°LOW TECHNICAL RISK
°LOW MAINTENANCE REQUIREMENTS
°CAN BE LOCATED UNDER AN EXISTING SEAT WITH MINOR MODIFICATIONS
°LOW COST

DISADVANTAGES:

°FOR HUMAN WASTE ONLY (CANNOT PROCESS BOTTLES, CANS, ETC.)
°REQUIRES WATER FOR OPERATION
°REQUIRES CHEMICALS FOR ODOR CONTROL AND MICROBIAL REDUCTION
°CAPACITY LIMITED BY WASTE HOLDING TANK, CHEMICAL SUPPLY, AND WATER SUPPLY
°DUMPING OF UNAUTHORIZED MATERIAL (i.e. CANS, BOTTLES, ETC.) MAY INCAPACITATE SYSTEM

## CONCEPT #7 - COMBINATION SYSTEM: BAFFLED DUMP WITH CHEMICAL TOILET




SPECIFICATIONS:

°SEPARATE DISPOSAL OF HUMAN WASTE
°SELF CONTAINED WATER SUPPLY
°SELF CONTAINED WASTE HOLDING TANK CAN BE PUMPED OVERBOARD WHEN FULL
°CHEMICAL ADDITIVE IN WASTE HOLDING TANK ELIMINATES ODORS
°UTILIZES PNEUMATICS TO PURGE DUMP CHUTE COMPARTMENTS
°WASTE OTHER THAN HUMAN WASTE DISPOSED OF THROUGH CHUTE TO EXTERIOR OF VEHICLE
°SAME OPERATIONAL SEQUENCE AS CONCEPT #1

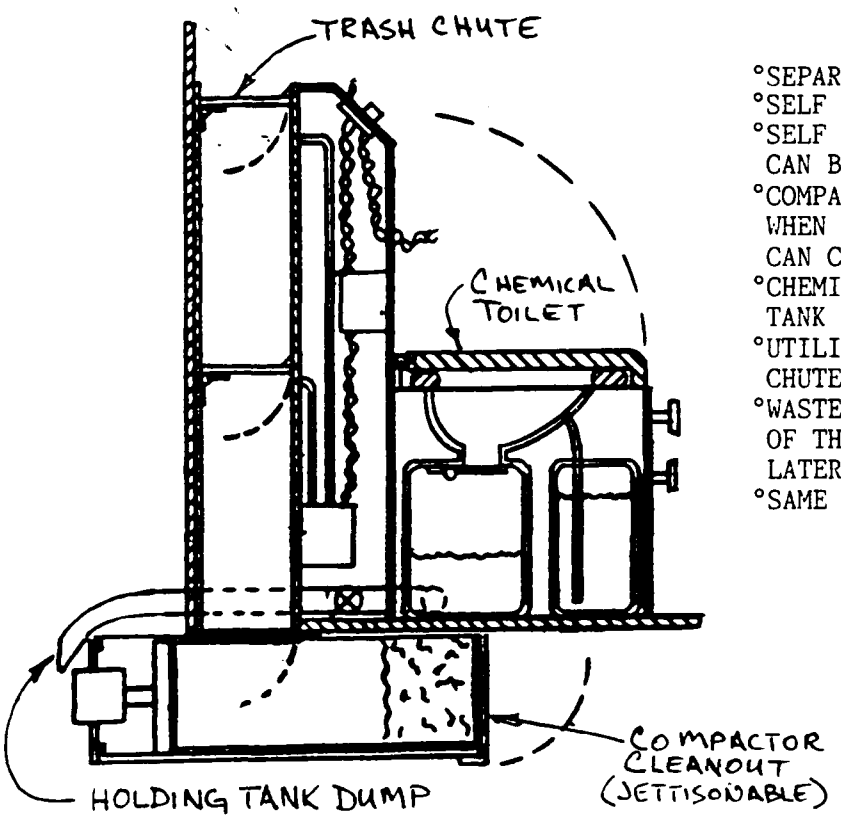
ADVANTAGES:

°LOW POWER REQUIREMENTS
°HIGH CAPACITY
°SIMPLE OPERATION
°HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
°DOES NOT REQUIRE PERSONNEL TO LEAVE VEHICLE TO EMPTY SYSTEM
°LOW TECHNICAL RISK
°LOW MAINTENANCE REQUIREMENTS
°LOW TO MEDIUM COST
°CAN HOLD HUMAN WASTE FOR LATER DISPOSAL, OR DUMP TO EXTERIOR
°FAILURE OR OVERLOAD OF CHEMICAL TOILET - CAN USE BAFFLED DUMP AS BACKUP

DISADVANTAGES:

°NON HUMAN WASTE (BOTTLES, CANS, ETC.) IS DEPOSITED DIRECTLY ON GROUND (causing problems during non-combat operation, and possibly permitting tracking of vehicle movements during combat)
°REQUIRES WATER FOR OPERATION
°REQUIRES CHEMICALS FOR ODOR CONTROL AND MICROBIAL REDUCTION
°CAPACITY LIMITED BY WASTE HOLDING TANK, CHEMICAL SUPPLY, AND WATER SUPPLY
°DUMPING OF UNAUTHORIZED MATERIAL (i.e. CANS, BOTTLES, ETC.) MAY INCAPACITATE CHEMICAL TOILET SYSTEM

## CONCEPT #8 - COMBINATION SYSTEM: BAFFLED COMPACTOR WITH CHEMICAL TOILET




SPECIFICATIONS:

°SEPARATE DISPOSAL OF HUMAN WASTE
°SELF CONTAINED WATER SUPPLY
°SELF CONTAINED WASTE HOLDING TANK CAN BE PUMPED OVERBOARD WHEN FULL
°COMPACTOR CLEANOUT CAN BE JETTISONED WHEN COMPACTOR IS FULL AND MISSION CAN CONTINUE
°CHEMICAL ADDITIVE IN WASTE HOLDING TANK ELIMINATES ODORS
°UTILIZES PNEUMATICS TO PURGE DUMP CHUTE COMPARTMENTS
°WASTE OTHER THAN HUMAN WASTE DISPOSED OF THROUGH CHUTE AND COMPACTED FOR LATER DISPOSAL
°SAME OPERATIONAL SEQUENCE AS CONCEPT #3

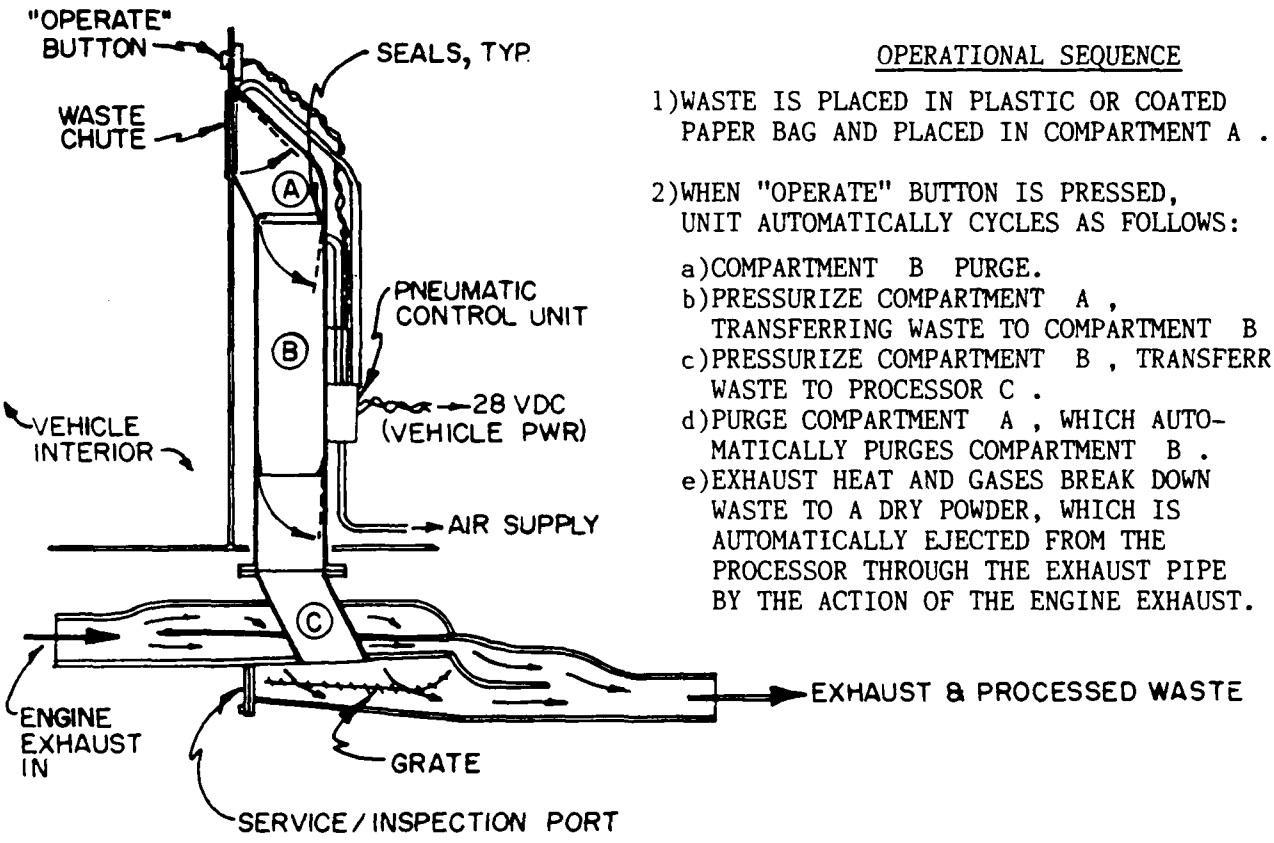
ADVANTAGES:

°LOW POWER REQUIREMENTS
°HIGH CAPACITY
°SIMPLE OPERATION
°HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
°DOES NOT REQUIRE PERSONNEL TO LEAVE VEHICLE TO EMPTY SYSTEM
°DOES NOT DUMP WASTE DIRECTLY ON GROUND - STORES FOR LATER DISPOSAL
°HAS THE CAPABILITY TO DUMP OR PURGE BOTH SYSTEMS IN THE FIELD, PERMITTING EXTENDED MISSIONS WITHOUT RETURN FOR MAINTENANCE
°LOW TO MEDIUM TECHNICAL RISK
°LOW TO MEDIUM COST
°LOW TO MEDIUM MAINTENANCE REQUIREMENTS
°HUMAN WASTE DISPOSAL SIMPLIFIED - PUMPOUT AT DEPOT

DISADVANTAGES:

°REQUIRES WATER FOR OPERATION
°REQUIRES CHEMICALS FOR ODOR CONTROL AND MICROBIAL REDUCTION
°DUMPING OF UNAUTHORIZED MATERIAL INTO TOILET MAY INCAPACITATE THAT PORTION OF THE SYSTEM
°SIZE OF SYSTEM MAY BE TOO LARGE FOR SOME APPLICATIONS

## CONCEPT #9 - BAFFLED DUMP SYSTEM WITH EXHAUST POWERED WASTE PROCESSOR




OPERATIONAL SEQUENCE

1)WASTE IS PLACED IN PLASTIC OR COATED PAPER BAG AND PLACED IN COMPARTMENT A .

2)WHEN "OPERATE" BUTTON IS PRESSED, UNIT AUTOMATICALLY CYCLES AS FOLLOWS:

a)COMPARTMENT B PURGE.
b)PRESSURIZE COMPARTMENT A , TRANSFERRING WASTE TO COMPARTMENT B .
c)PRESSURIZE COMPARTMENT B , TRANSFERRING WASTE TO PROCESSOR C .
d)PURGE COMPARTMENT A , WHICH AUTOMATICALLY PURGES COMPARTMENT B .
e)EXHAUST HEAT AND GASES BREAK DOWN WASTE TO A DRY POWDER, WHICH IS AUTOMATICALLY EJECTED FROM THE PROCESSOR THROUGH THE EXHAUST PIPE BY THE ACTION OF THE ENGINE EXHAUST.

ADVANTAGES:

°LOW POWER REQUIREMENTS
°HIGH CAPACITY
°SIMPLE OPERATION
°HANDLES ALL TYPES OF WASTE TO BE ENCOUNTERED
°DOES NOT REQUIRE PERSONNEL TO LEAVE VEHICLE TO EMPTY SYSTEM
°LOW TECHNICAL RISK
°LOW MAINTENANCE REQUIREMENTS
°LOW COST
°MINIMAL VEHICLE IMPACT
°GOOD RETROFIT POSSIBILITIES
°REQUIRES NO WASTE HANDLING/PROCESSING AFTER MISSION
°REQUIRES NO WATER OR CHEMICALS FOR OPERATION

DISADVANTAGES

°REQUIRES OPERATION OF VEHICLE ENGINE TO PROCESS WASTE
°REQUIRES THE DEVELOPMENT OF SPECIAL BAGS AND CLOSURES TO ASSURE PROPER BREAKDOWN DURING THE PROCESSING CYCLE.

# APPENDIX B

# BENCH MODEL AND

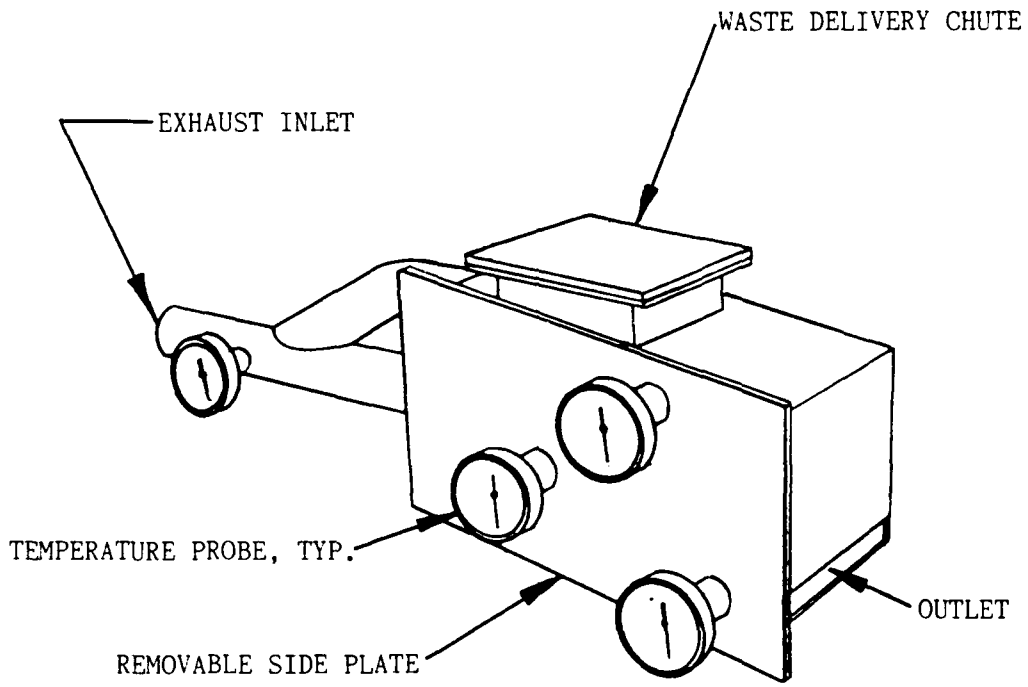
# BENCH MODEL TEST RESULTS

## BENCH MODEL WPU

A working model of the concept Waste Processing Unit (WPU) was fabricated for the specific purpose of demonstrating the feasibility of the approach selected. The Bench Model WPU differs from an operational unit in several areas. First, the entire side of the unit is removable to permit inspection of the remaining contents (if any) after a test. Second, the unit has provisions for mounting four (4) temperature probes in various areas of the internal flow. Third, no specialized waste delivery system has been supplied, but a flange has been provided for mounting such systems in the future. Finally, the unit has been fabricated from hot rolled steel plate instead of stainless steel to facilitate modifications for testing purposes. Figure C.1.1 shows the overall configuration of the WPU Bench Model and a diagram of it's internal configuration.

## PRELIMINARY BENCH MODEL TESTING

The Bench Model WPU was attached to the exhaust pipe of a six cylinder automotive type engine (gasoline) approximately 3 feet from the exhaust manifold, and instrumented as shown on the WPU Initial Bench Test Data Sheet. The engine was run at approximately 2000 rpm , and the response of the WPU was recorded to determine the thermal pattern within the unit. Results of this preliminary testing indicate that the choke section does not provide additional heating within the incineration chamber as expected, but does provide a positive bypass route for exhaust gases in the unlikely event of a blockage in the incineration chamber without significantly reducing the normal operational efficiency of the unit. See the WPU Initial Bench Test Data Sheet for additional findings, recommendations, and comments.



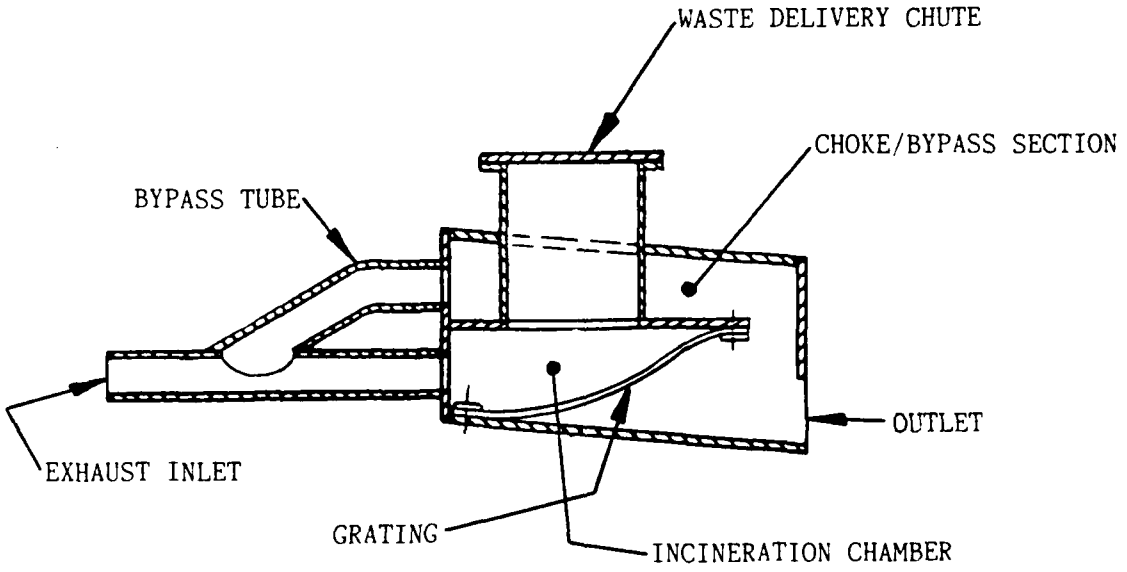
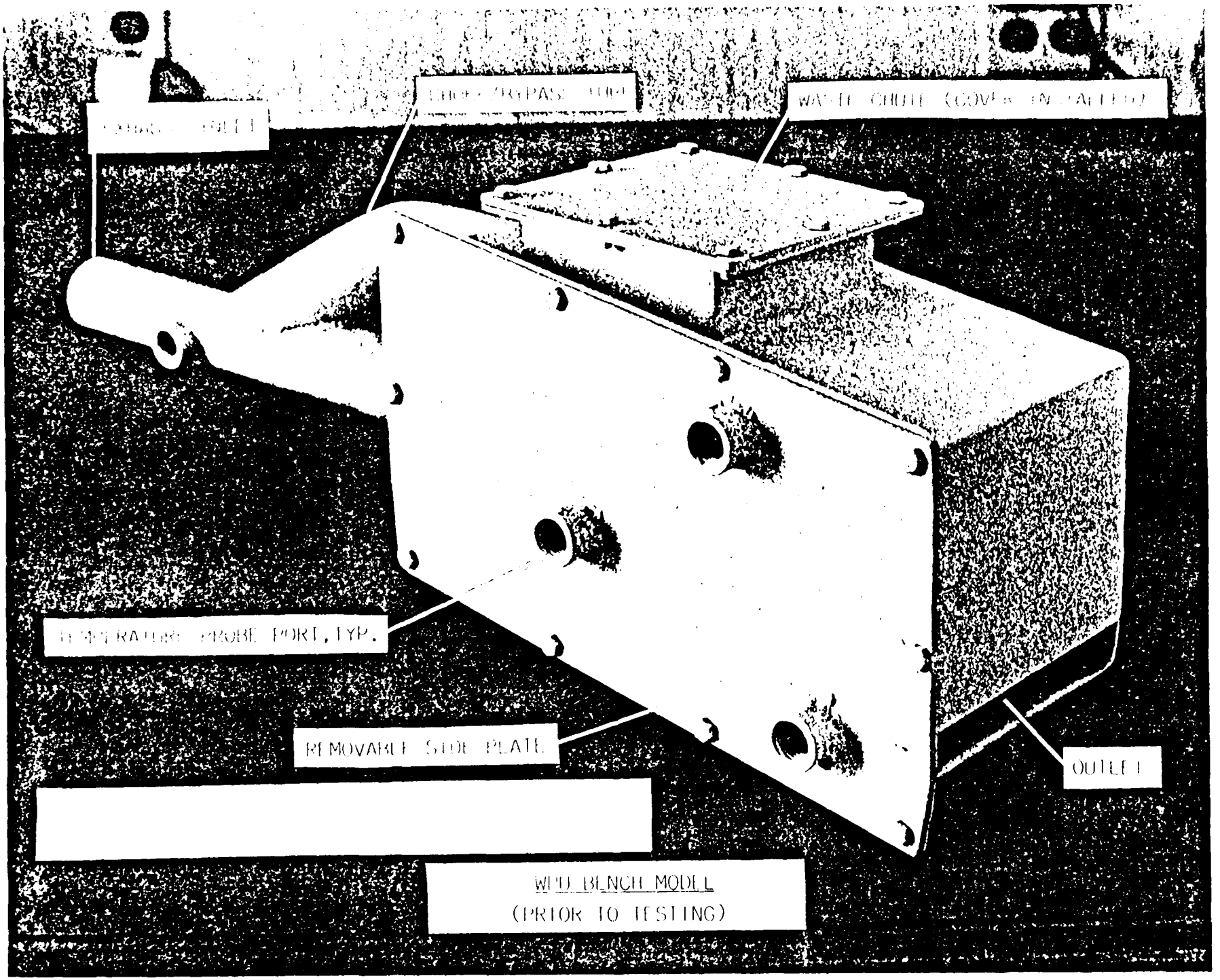
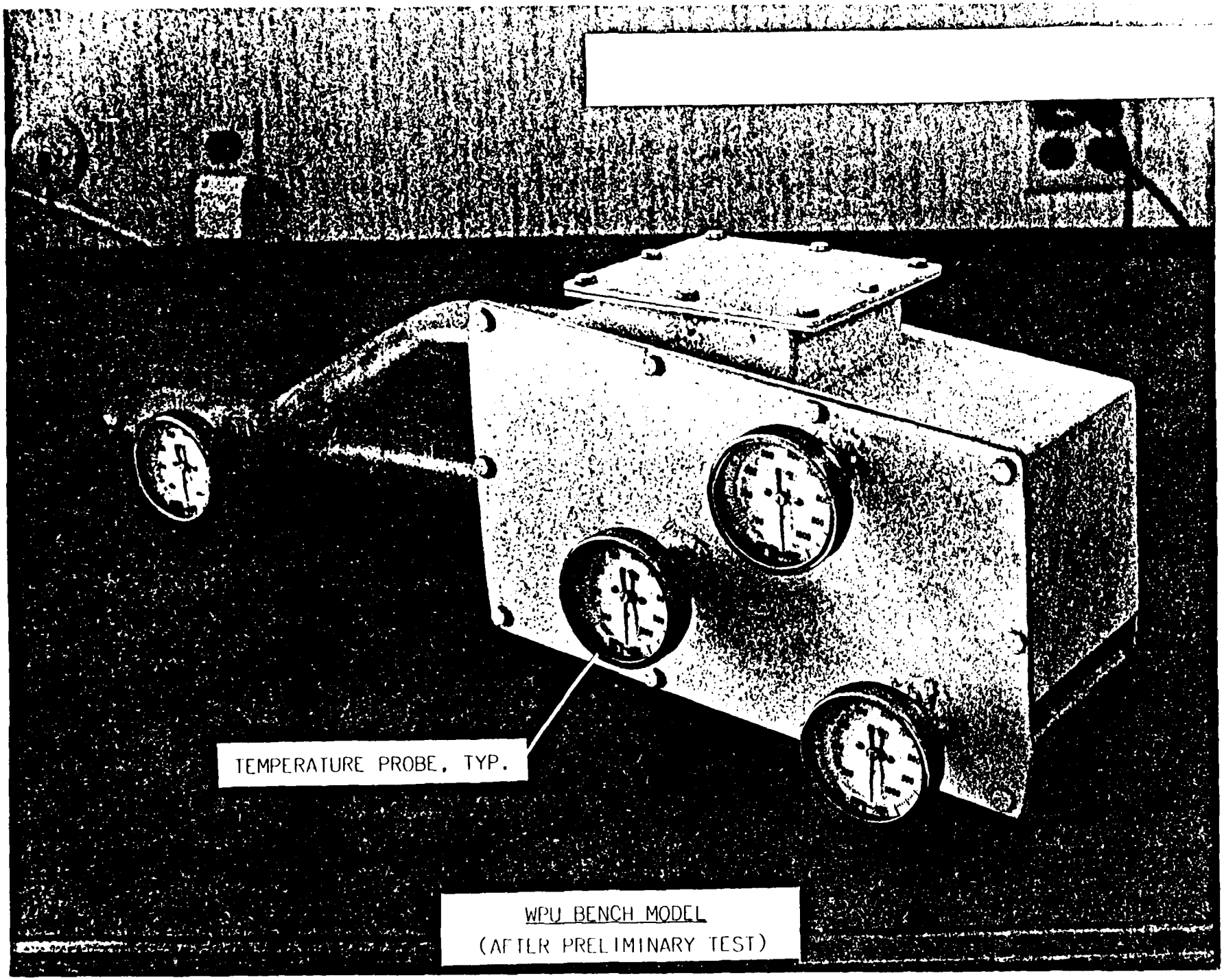



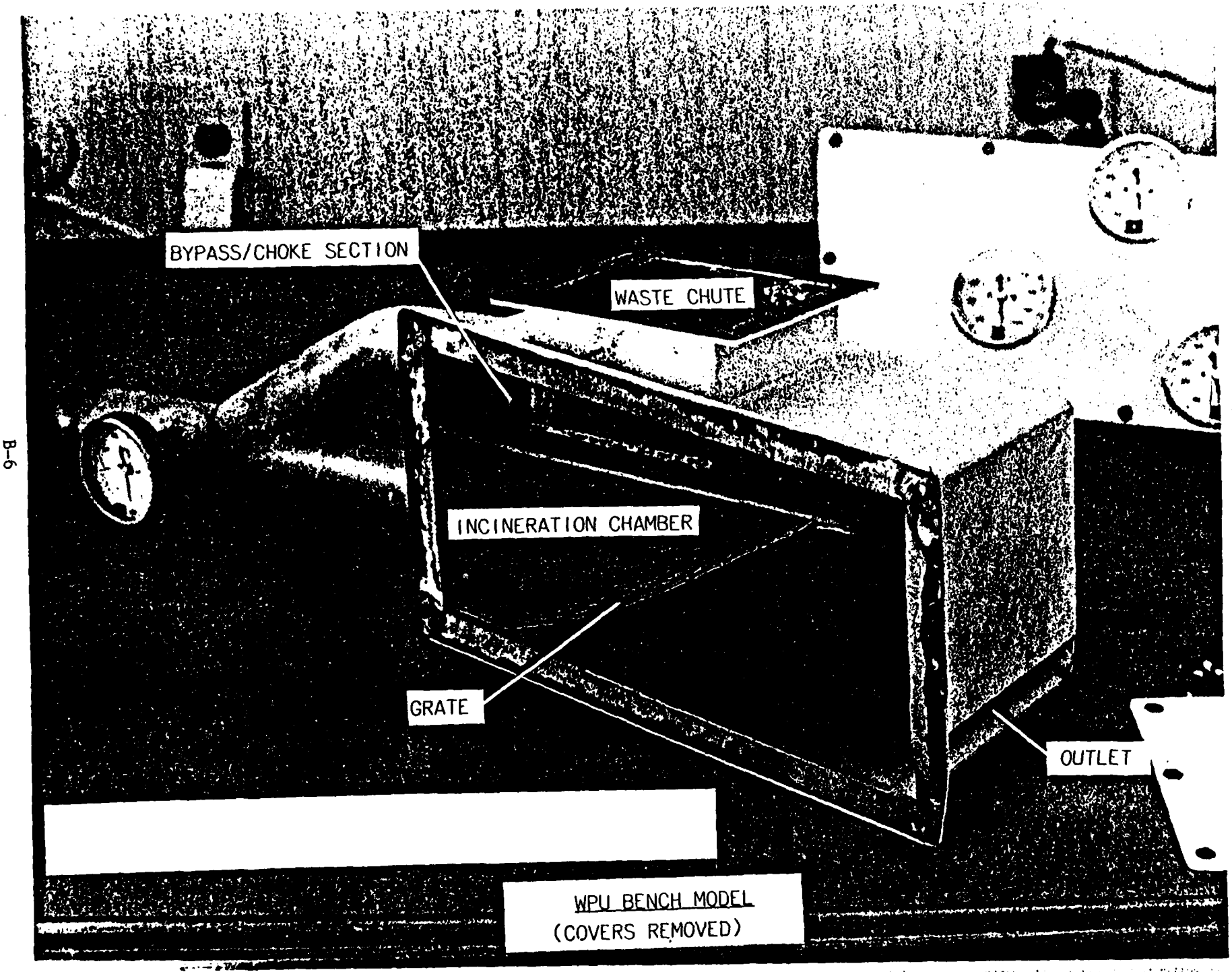

FIGURE C.1.1 - WPU BENCH MODEL



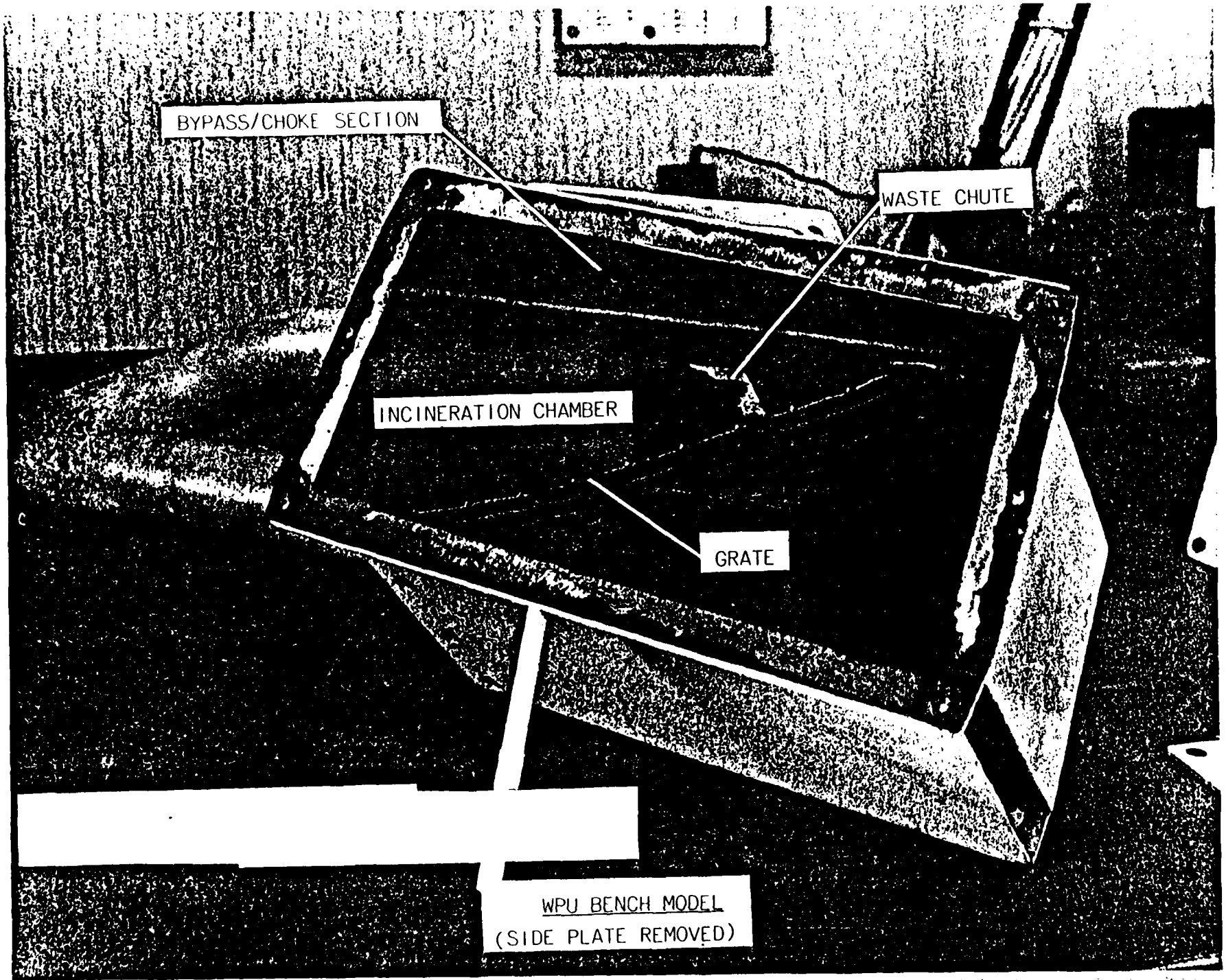

WIND BENCH MODEL
(PRIOR TO TESTING)




WPU BENCH MODEL
(AFTER PRELIMINARY TEST)

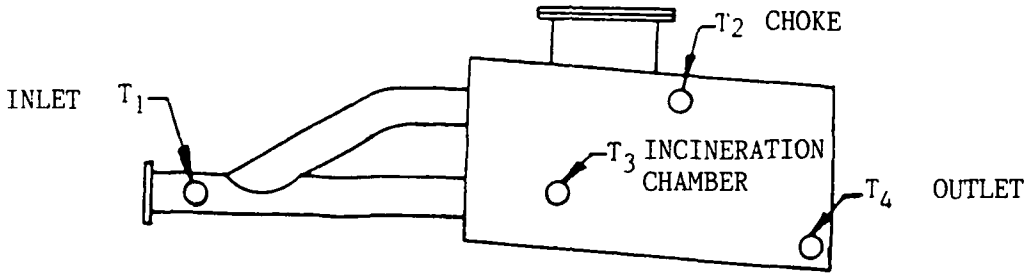



WPU BENCH MODEL
(COVERS REMOVED)


BYPASS/CHOKE SECTION
WASTE CHUTE
INCINERATION CHAMBER
GRATE
WPU BENCH MODEL
(SIDE PLATE REMOVED)

WPU INITIAL BENCH TEST DATA SHEET

TEST DATE: 86/01/13




| TIME: | 17:50 | 17:54 | 17:57 | 18:01 | 18:06 | SHUTDOWN |
|---|---|---|---|---|---|---|
| $T_1$ | 730 | 780 | 795 | 805 | 815 | |
| $T_2$ | 260 | 320 | 360 | 385 | 405 | |
| $T_3$ | 450 | 500 | 520 | 540 | 550 | |
| $T_4$ | 470 | 520 | 540 | 560 | 575 | |
| TEMPERATURE, °F | | | | | | |

OBSERVATIONS/COMMENTS

1. Bench Model mounted on exhaust of 6 cyl. gasoline engine operating at 2000 RPM for duration of this test

2. Cost in 6 cyl. engine (used) for test bed for Phase II testing. (This set up is awkward and difficult to use.)

3. Insulation will increase T downstream of inlet.

4. Choke not operating as expected - Temperature lower @ $T_2$ than elsewhere. Leave flow path in, however, for bypass function.

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